

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1 1. (Currently Amended) A computer-implemented method of adding
2 a new node to a network multicast group, with a specified group membership
3 status, wherein members of a corresponding routing tree ~~are configured to route~~
4 multicast messages among members of the group, the method comprising:
5 selecting a minimum spanning tree of the network;
6 selecting the new node as the current node;
7 examining the routing tree membership statuses of nodes that are linked to
8 the current node by links included in the minimum spanning tree;
9 until said examining is halted, selecting a peer node of the current node as
10 the current node and repeating said examining;
11 halting the examining when a final node is examined if:
12 the final node is a Full member of the routing tree; or
13 the final node is a SendOnly member of the routing tree and the
14 specified group membership status of the new node is SendOnly; and
15 for each given node in the path from the new node to the final node,
16 setting the routing tree membership status of the given node equal to the specified
17 group membership status of the new node.

1 2. (Original) The method of claim 1, further comprising:
2 maintaining a queue for storing network nodes for selection as current
3 node;

4 wherein a first peer of a current node is added to said queue if:
5 said first peer is coupled to the current node by a link included in
6 the minimum spanning tree;
7 said first peer is not a Full member of the routing tree; and
8 the routing tree membership status of said first peer and the
9 specified group membership status of the new node are not both
10 SendOnly.

1 3. (Original) The method of claim 2, further comprising:
2 determining if said queue is empty if:
3 the specified group membership status of the new node is Full; and
4 the routing tree membership status of said first peer is SendOnly.

1 4. (Original) The method of claim 2, further comprising:
2 halting the examining if said queue is empty.

1 5. (Currently Amended) A computer readable medium storing
2 instructions that, when executed by a computer, cause the computer to perform a
3 method of adding a new node to a network multicast group, with a specified group
4 membership status, wherein members of a corresponding routing tree ~~are~~
5 ~~configured to~~ route multicast messages among members of the group, the method
6 comprising:
7 selecting a minimum spanning tree of the network;
8 selecting the new node as the current node;
9 examining the routing tree membership statuses of nodes that are linked to
10 the current node by links included in the minimum spanning tree;
11 until said examining is halted, selecting a peer node of the current node as
12 the current node and repeating said examining;

13 halting the examining when a final node is examined if:
14 the final node is a Full member of the routing tree; or
15 the final node is a SendOnly member of the routing tree and the
16 specified group membership status of the new node is SendOnly; and
17 for each given node in the path from the new node to the final node,
18 setting the routing tree membership status of the given node equal to the specified
19 group membership status of the new node.

1 6. (Currently Amended) A computer-implemented method of adding
2 a first node to a multicast group of network nodes, wherein members of a
3 corresponding routing tree ~~are configured to route~~ multicast messages among
4 members of the group, the method comprising:
5 (a) receiving a first request to include a first network node in a
6 multicast group as one of a Full member and a SendOnly member;
7 (b) setting a GroupStatus of the first node according to the first
8 request, wherein said GroupStatus indicates a membership status in the multicast
9 group;
10 (c) selecting a minimum spanning tree of the network;
11 (d) selecting the first node as the current node;
12 (e) selecting a peer node of the current node, wherein a TreeStatus of
13 the selected peer has not been examined since the first request was received,
14 wherein said TreeStatus indicates a membership status in the routing tree;
15 (f) performing one or more of the following examinations:
16 (f1) determining if said TreeStatus of the selected peer is Full;
17 (f2) determining if said TreeStatus of the selected peer is
18 SendOnly and said GroupStatus of the current node is SendOnly; and
19 (f3) determining if a network link coupling the current node to
20 the selected peer is part of the selected minimum spanning tree;

21 (g) repeating steps (e) — to steps (g) until one of:
22 (g1) at least one peer of the current node has been examined;
23 and
24 (g2) one of said step (f1) and said step (f2) determinations
25 succeed;
26 (h) if neither of said step (f1) and said step (f2) determinations has
27 succeeded, setting a peer of the current node as the current node;
28 (i) repeating steps (e) — to steps (h) until one of:
29 (i1) all nodes in the routing tree have been examined; and
30 (i2) one of said step (f1) and said step (f2) determinations
31 succeed;
32 (j) for each given node in the minimum spanning tree, from the new
33 node to the last peer examined, setting a TreeStatus of the given node equal to
34 said GroupStatus of the new node.

1 7. (Currently Amended) The method of claim 6, further comprising,
2 after step (d):
3 comparing said GroupStatus of the first node to said TreeStatus of the first
4 node.

1 8. (Original) The method of claim 6, further comprising:
2 maintaining a queue in which to queue nodes for selection as the current
3 node.

1 9. (Currently Amended) The method of claim 8, further comprising, if
2 said step (f3) determination succeeds:
3 adding the selected peer to said queue.

1 10. (Currently Amended) The method of claim 9, further comprising, if
2 said step (f3) determination succeeds:
3 if said TreeStatus of the selected peer is SendOnly and said GroupStatus of
4 the new node is Full, determining if said queue is empty.

1 11. (Currently Amended) A computer readable medium storing
2 instructions that, when executed by a computer, cause the computer to perform a
3 method of adding a first node to a multicast group of network nodes, wherein
4 members of a corresponding routing tree ~~are configured to route~~ multicast
5 messages among members of the group, the method comprising:
6 (a) receiving a first request to include a first network node in a
7 multicast group as one of a Full member and a SendOnly member;
8 (b) setting a GroupStatus of the first node according to the first
9 request, wherein said GroupStatus indicates a membership status in the multicast
10 group;
11 (c) selecting a minimum spanning tree of the network;
12 (d) selecting the first node as the current node;
13 (e) selecting a peer node of the current node, wherein a TreeStatus of
14 the selected peer has not been examined since the first request was received,
15 wherein said TreeStatus indicates a membership status in the routing tree;
16 (f) performing one or more of the following examinations:
17 (f1) determining if said TreeStatus of the selected peer is Full;
18 (f2) determining if said TreeStatus of the selected peer is
19 SendOnly and said GroupStatus of the current node is SendOnly; and
20 (f3) determining if a network link coupling the current node to
21 the selected peer is part of the selected minimum spanning tree;
22 (g) repeating steps (e) — to steps (g) until one of:
23 (g1) at least one peer of the current node has been examined;

24 and
25 (g2) one of said step (f1) and said step (f2) determinations
26 succeed;
27 (h) if at least one peer of the current node has been examined, setting a
28 peer of the current node as the current node;
29 (i) repeating steps (e) — to steps (h) until one of:
30 (i1) all nodes in the routing tree have been examined; and
31 (i2) one of said step (f1) and said step (f2) determinations
32 succeed;
33 (j) for each given node in the minimum spanning tree, from the new
34 node to the last peer examined, setting a TreeStatus of the given node equal to
35 said GroupStatus of the new node.

1 12. (Currently Amended) A computer-implemented method of adding
2 a new node to a network multicast group, with a specified group membership
3 status, wherein members of a corresponding routing tree ~~are configured to route~~
4 multicast messages among members of the group, the method comprising:
5 identifying a minimum spanning tree of the network;
6 selecting the new node as the current node;
7 until a final node having a routing tree membership status greater than or
8 equal to the specified group membership status of the new node is identified,
9 repeating:
10 examining the routing tree membership statuses of peer nodes of
11 the current node; and
12 selecting as current node a peer node of the current node that is
13 coupled to the current node by a link included in the minimum spanning
14 tree; and
15 setting the routing tree membership status of each node in the minimum

16 spanning tree, from the new node to the final node, to the specified group
17 membership status of the new node.

1 13. (Original) The method of claim 12, wherein a node's routing tree
2 membership status and group membership status are each one of the following,
3 from lesser status to greater status: non-member, SendOnly, Full.

1 14. (Currently Amended) A computer readable medium storing
2 instructions that, when executed by a computer, cause the computer to perform a
3 method of adding a new node to a network multicast group, with a specified group
4 membership status, wherein members of a corresponding routing tree are
5 ~~configured to~~ route multicast messages among members of the group, the method
6 comprising:
7 identifying a minimum spanning tree of the network;
8 selecting the new node as the current node;
9 until a final node having a routing tree membership status greater than or
10 equal to the specified group membership status of the new node is identified,
11 repeating:
12 examining the routing tree membership statuses of peer nodes of
13 the current node; and
14 selecting as current node a peer node of the current node that is
15 coupled to the current node by a link included in the minimum spanning
16 tree; and
17 setting the routing tree membership status of each node in the minimum
18 spanning tree, from the new node to the final node, to the specified group
19 membership status of the new node.

1 15. (Currently Amended) A computer-implemented method of

2 removing a first node from a network multicast group, wherein members of a
3 corresponding routing tree ~~are configured to route~~ multicast messages among
4 members of the group, the method comprising:
5 queuing the first node in a queue;
6 until the queue is empty, repeating the following, in order:
7 (a) removing the most recently queued node to serve as the
8 current node;
9 (b) returning to step (a) if the group membership status of the
10 current node is Full;
11 (c) identifying a number of local ports of the current node that
12 are on;
13 (d) returning to step (a) if the number is greater than one;
14 (e) if the number of local ports that are on is equal to zero:
15 (e1) for each peer node having a local port to the current
16 node on, turning off said peer node's local port to the current node
17 and adding said peer node to the queue; and
18 (e2) setting the routing tree membership status of the
19 current node to None; and
20 (f) if the number of local ports that are on is equal to one:
21 (f1) on a sole peer node coupled to the one local port,
22 turning off the sole peer node's local port to the current node if the
23 sole peer's local port to the current node is on;
24 (f2) adding the sole peer node to the queue;
25 (f3) if zero peer nodes have local ports to the current
26 node on and the group membership status of the current node is
27 None:
28 turning off the one local port of the current node
29 that is on; and

30 setting the routing tree membership status of the
31 current node to None; and
32 (f4) otherwise, setting the routing tree membership
33 status of the current node to SendOnly.

1 16. (Currently Amended) The method of claim 15, further comprising,
2 prior to said repeating of steps (a) to steps (f):
3 setting the group membership status of the first node to one of None and
4 SendOnly.

1 17. (Currently Amended) A computer readable medium storing
2 instructions that, when executed by a computer, cause the computer to perform a
3 method of removing a first node from a network multicast group, wherein
4 members of a corresponding routing tree ~~are configured to~~ route multicast
5 messages among members of the group, the method comprising:
6 queuing the first node in a queue;
7 until the queue is empty, repeating the following, in order:
8 (a) removing the most recently queued node to serve as the
9 current node;
10 (b) returning to step (a) if the group membership status of the
11 current node is Full;
12 (c) identifying a number of local ports of the current node that
13 are on;
14 (d) returning to step (a) if the number is greater than one;
15 (e) if the number of local ports that are on is equal to zero:
16 (e1) for each peer node having a local port to the current
17 node on, turning off said peer node's local port to the current node
18 and adding said peer node to the queue; and

19 (e2) setting the routing tree membership status of the
20 current node to None; and
21 (f) if the number of local ports that are on is equal to one:
22 (f1) on the sole peer node coupled to the one local port,
23 turning off the sole peer node's local port to the current node if the
24 sole peer's local port to the current node is on;
25 (f2) adding the sole peer node to the queue;
26 (f3) if zero peer nodes have local ports to the current
27 node on and the group membership status of the current node is
28 None:
29 turning off the one local port of the current node
30 that is on; and
31 setting the routing tree membership status of the
32 current node to None; and
33 (f4) otherwise, setting the routing tree membership
34 status of the current node to SendOnly.

1 18. (Currently Amended) A computer-implemented method of
2 removing a first node from a multicast group of network nodes, wherein members
3 of a corresponding routing tree ~~are configured to route~~ multicast messages among
4 members of the group, the method comprising:
5 receiving a first request to remove a first network node from membership
6 in a multicast group, wherein the first node was one of a Full member and a
7 SendOnly member of the multicast group;
8 setting a GroupStatus of the first node to one of None and SendOnly,
9 wherein said GroupStatus indicates a membership status in the multicast group;
10 queuing the first node in a queue;
11 until the queue is empty, repeating:

12 (a) dequeuing a node from the queue to be the current node;
 13 (b) determining if the GroupStatus of the current node is Full;
 14 (c) determining a number of local ports of the current node that are on;
 15 (d) if the number of local ports is equal to zero:
 16 (d1) for each peer of the current node with a local port to the
 17 current node turned on:
 18 (d1') setting the local port of the peer to off; and
 19 (d1'') adding the peer to the queue; and
 20 (d2) setting a TreeStatus of the current node to None, wherein
 21 said TreeStatus indicates a membership status in the routing tree; and
 22 (e) if the number is equal to one:
 23 (e1) on the one peer coupled to the one local port of the current
 24 node, setting the local port of the one peer to the current node to off;
 25 (e2) adding the one peer to the queue;
 26 (e3) if the GroupStatus of the current node is None and zero
 27 peers of the current node have a local port to the current node on:
 28 (e3') turning off the one local port of the current node; and
 29 (e3'') setting the TreeStatus of the current node to None;
 30 and
 31 (e4) otherwise, setting the TreeStatus of the current node to
 32 SendOnly.

1 19. (Currently Amended) The method of claim 18, wherein said step
 2 (a) comprises:
 3 dequeuing ~~the~~ a given node most recently added to the queue to be the
 4 current node.

1 20. (Currently Amended) A computer readable medium storing

2 instructions that, when executed by a computer, cause the computer to perform a
3 method of removing a first node from a multicast group of network nodes,
4 wherein members of a corresponding routing tree ~~are configured to route~~ multicast
5 messages among members of the group, the method comprising:
6 receiving a first request to remove a first network node from membership
7 in a multicast group, wherein the first node was one of a Full member and a
8 SendOnly member of the multicast group;
9 setting a GroupStatus of the first node to one of None and SendOnly,
10 wherein said GroupStatus indicates a membership status in the multicast group;
11 queuing the first node in a queue;
12 until the queue is empty, repeating:
13 (a) dequeuing a node from the queue to be the current node;
14 (b) determining if the GroupStatus of the current node is Full;
15 (c) determining a number of local ports of the current node that are on;
16 (d) if the number is equal to zero:
17 (d1) for each peer of the current node with a local port to the
18 current node turned on:
19 (d1') setting the local port of the peer to off; and
20 (d1'') adding the peer to the queue; and
21 (d2) setting a TreeStatus of the current node to None, wherein
22 said TreeStatus indicates a membership status in the routing tree; and
23 (e) if the number is equal to one:
24 (e1) on the one peer coupled to the one local port of the current
25 node, setting the local port of the one peer to the current node to off;
26 (e2) adding the one peer to the queue;
27 (e3) if the GroupStatus of the current node is None and zero
28 peers of the current node have a local port to the current node on:
29 (e3') turning off the one local port of the current node; and

30 (e3") setting the TreeStatus of the current node to None;
31 and
32 (e4) otherwise, setting the TreeStatus of the current node to
33 SendOnly.

1 21. (Original) A system for managing membership in a multicast group
2 and a corresponding routing tree for routing multicast messages within the
3 multicast group, the apparatus comprising:
4 a network node coupling the apparatus to a network;
5 a subnet administrator configured to receive requests to change the
6 membership of the multicast group;
7 a subnet manager configured to update network nodes' routing tables
8 when the routing tree is modified in response to a change in membership of the
9 multicast group; and
10 a subnet management coordinator configured to:
11 make a non-member into a Full or SendOnly member of the
12 multicast group;
13 make a Full or SendOnly member into a non-member of the
14 multicast group; and
15 update the membership of the routing tree in response to a change
16 in the membership of the multicast group.

1 22. (Original) The system of claim 21, wherein said subnet
2 management coordinator makes a non-member into a Full or SendOnly member
3 of the multicast group by:
4 setting the group membership status of the non-member to the group
5 membership status specified in a request that was received to make the non-
6 member a member of the multicast group;

7 identifying a minimum spanning tree of the network;
8 selecting the non-member as the current node;
9 until a final node having a routing tree membership status greater than or
10 equal to the group membership status of the non-member is identified, repeating:
11 examining the routing tree membership statuses of peer nodes of
12 the current node; and
13 selecting as current node a peer node of the current node that is
14 coupled to the current node by a link included in the minimum spanning
15 tree;
16 setting the routing tree membership status of each node in the minimum
17 spanning tree, from the non-member to the final node, to the specified group
18 membership status of the new node.

1 23. (Original) The system of claim 22, wherein a node's routing tree
2 membership status and group membership status are each one of the following,
3 from lesser status to greater status: non-member, SendOnly, Full.

1 24. (Currently Amended) The system of claim 21, wherein said subnet
2 management coordinator makes a Full or SendOnly member into a non-member
3 of the multicast group by:
4 queuing the member in a queue;
5 until the queue is empty, repeating the following, in order:
6 (a) removing the most recently queued member to serve as the
7 current node;
8 (b) returning to step (a) if the group membership status of the
9 current node is Full;
10 (c) identifying a number of local ports of the current node that
11 are on;

12 (d) returning to step (a) if the number is greater than one;
13 (e) if the number is equal to zero:
14 (e1) for each peer of the current node that has a local
15 port to the current node on, turning off said peer's local port to the
16 current node and adding said peer to the queue; and
17 (e2) setting the routing tree membership status of the
18 current node to non-member; and
19 (f) if the number is equal to one:
20 (f1) on the one peer coupled to the one local port,
21 turning off the peer's local port to the current node;
22 (f2) adding the one peer to the queue;
23 (f3) if zero peers have local ports to the current node on
24 and the group membership status of the current node is non-
25 member:
26 turning off the one local port of the current node
27 that is on; and
28 setting the routing tree membership status of the
29 current node to non-member; and
30 (f4) otherwise, setting the routing tree membership
31 status of the current node to SendOnly.

1 25. (Original) The system of claim 21, wherein said network node is
2 one of a channel adapter and a network switch.